Lifestyle factors and social ties associated with the frequency of laughter after the Great East Japan Earthquake: Fukushima Health Management Survey

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Abstract

Purpose Although mental health problems such as depression after disasters have been reported, positive psychological factors after disasters have not been examined. Recently, the importance of positive affect to our health has been recognised. We therefore investigated the frequency of laughter and its related factors among residents of evacuation zones after the Great East Japan Earthquake of 2011.

Methods In a cross-sectional study on 52,320 participants aged 20 years and older who were included in the Fukushima Health Management Survey in Japan's fiscal year 2012, associations of the frequency of laughter with disaster-related factors, such as a changed work situation, the number of family members, and the number of address changes, and other sociodemographic, psychological, and lifestyle factors were examined using logistic regression analysis. The frequency of laughter was assessed using a single-item question: "How often do you laugh out loud?"

Results The proportion of those who laugh almost every day was 27.1%. Multivariable models adjusted for sociodemographic, psychological, and lifestyle factors demonstrated that an increase in the number of family members and fewer changes of address were significantly associated with a high frequency of laughter. Mental health, regular exercise, and participation in recreational activities were also associated with a high frequency of laughter.

Conclusion Changes in lifestyle factors after the disaster were associated with the frequency of laughter in the evacuation zone. Future longitudinal studies are needed to examine what factors can increase the frequency of laughter.

Keywords: Frequency of laughter; Disaster; Lifestyle and social factors; Cross-sectional study

Introduction

There is a proverb that states, “Fortune comes in by a merry gate”. Recently, the health benefits of experiencing laughter have received attention. Previous experimental studies have found that mirthful laugher moderates stress, improves the immune system [1, 2], decreases allergic responses [3], reduces the increase in postprandial blood glucose in patients with diabetes [4], enhances free radical-scavenging capacity in saliva [5], and helps to improve blood vessel function [6]. Moreover, an increasing number of interventional studies using laughter have shown positive effects on depression, insomnia, self-rated health, and haemoglobin A1c which is an indicator of diabetes [7-9]. These findings suggest that increasing the frequency of laughter might be useful for health promotion.

However, little is known about the factors associated with the frequency of laughter in daily life. Kotani [10] found that the frequency of daily laughter for older women was associated with a sense of well-being, less mental stress, and having the opportunity to give advice to friends. Another study found that older people with hobbies reported a higher frequency of laughter compared with those without hobbies [11]. In addition, a recent epidemiological study in Japan demonstrated that the frequency of daily laughter was associated with participation in social activities and exercise habits among older adults [12]. Laughter in daily life seems to be associated with psychosocial and lifestyle factors. However, the study populations in these epidemiological studies were community-dwelling older people. Studies that have examined the frequency of laughter among a broad generation of adults are rare.

In this study, we focused on residents of evacuation zones in Fukushima Prefecture after the Great East Japan Earthquake on 11 March 2011, because they experienced many changes in lifestyle and socioeconomic statuses, as well as mental stress and traumatic symptoms. These experienced factors might influence the frequency of laughter. Previous studies have reported increased mental health problems after disasters, focusing on forms of negative affect such as depression, anxiety, and posttraumatic stress symptoms [13, 14]. However, to our knowledge, few studies have examined positive affect after a disaster. Recently, the

importance of positive affect to human health has been recognised [15, 16], and it has been suggested that the absence of positive affects may be a more critical factor than the presence of negative affects. For example, previous studies have shown that the impact of depression on mortality and functional decline might result from the absence of positive affect rather than the presence of negative affect [17, 18]. In this study, we focused on the frequency of laughter as a positive psychological factor. Although factors associated with psychological stress following a disaster have been examined [14, 19, 20], little is known about the factors associated with the frequency of laughter.

This study investigated the disaster-related, socioeconomic, and lifestyle factors associated with the frequency of laughter among residents of evacuation zones.

Methods

Study population

This study was part of the Fukushima Health Management Survey. The Fukushima Health Management Survey is a large cohort study to monitor the long-term health of residents in Fukushima Prefecture after the earthquake, and to promote their future well-being. The details of this survey are described elsewhere [21]. We used cross-sectional data from the survey in Japan, in the 2012 fiscal year. The target population of the survey was 211,615 officially registered residents of nationally designated evacuation zones (including those evacuated or transferred to another prefecture) aged 0 years and older between 11 March 2011 and 1 April 2012. The zones included Hirono Town, Naraha Town, Tomioka Town, Kawauchi Village, Okuma Town, Futaba Town, Namie Town, Katsurao Village, Minamisoma City, Tamura City, Kawamata Town, Iitate Village, and a part of Date City. All residents of the evacuation zones were targeted for the survey. Questionnaires were mailed to residents in January 2013 and the deadline for responses was set to 6 months after the posting. The response rates of the survey were 41.2% for persons aged 0–14 years, and 29.8% for persons

aged 15 years and older. Because information on smoking and drinking statuses was used in this study, participants aged 20 years and older (n = 53,162) were included in the analysis, and participants with missing information on variables for the frequency of daily laughter (n = 842) were excluded. A total of 52,320 participants (23,115 men and 29,205 women) were included in the analysis.

Assessment of laughter

The daily frequency of laughter was assessed using a single-item question: "How often do you laugh out loud?" Four response options were provided: *almost every day*, *1–5 days per week*, *1–3 days per month*, and *almost never*. Participants chose one of these options. The one-year test-retest reliability of the item was assessed in a previous study in 2,680 men and women aged 30-74 years using the Spearman correlation coefficient, which was found to be 0.61 ($p < 0.001$). In addition, there were no regional and seasonal differences in the frequency of laughter among Japanese men and women (Partial Research Report of Health and Labour Science Research. http://www.fmu.ac.jp/home/epi/report/images/pdf/2014/pdf2-8.pdf, in Japanese). The item has been used in previous epidemiological studies in Japan [12, 22].

Assessment of disaster-related variables

Information on disaster-related factors was obtained from a self-reported questionnaire, which included "nuclear accident experience" (yes/no), and "living away from the family due to the disaster" (yes/no).

Assessment of lifestyle factors

Information on "a changed work situation" (change/no change) was obtained. The number of family members before and after the disaster was obtained, and "a change in the number of

family members" (decrease, no change, increase) was calculated. The number of address changes was obtained and classified into four categories: *0 times*, *1–2 times*, *3–4 times*, and *5 times or more*. Information on exercise habits (*almost every day*, *2–4 times per week*, *once per week*, or *almost never*), participation in recreational activities (usually, sometimes, or never), and smoking and drinking status were also obtained.

Assessment of other variables

Information on age, sex, psychological factors, self-rated health, and self-rated economic status were also obtained. Age was classified into four categories: 20–44 years, 45–64 years, 64–74 years, and older than 74 years. Mental health status was assessed using the Japanese version of the Kessler 6 (K6) scale [23, 24] and the Japanese version of the Posttraumatic Stress Disorder (PTSD) Checklist–Stressor-Specific Version (PCL-S) [25-27]. The K6 is used to measure non-specific psychological distress and asks respondents whether they have experienced six mental health symptoms during the past 30 days, on a 5-point Likert scale (0 to 4). Each item score was summed to generate the total K6 score ranging from 0 to 24, with higher scores indicating higher levels of psychological distress. Following a previous study, a score of ≥ 13 was defined as having psychological distress [28, 29]. A previous study, which examined the performance of the Japanese version of the K6 in detecting Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition (DSM-IV) mood and anxiety disorders, reported that the area under receiver operating characteristic curve (AUC) was 0.94 (95% confidence interval = 0.88 to 0.99) [23]. In the present study population, the Cronbach's alpha for the K6 was 0.92, indicating high internal reliability. The PCL-S is a 17-item self-reported checklist of PTSD symptoms that focuses on stressful experiences. In this study, stressful experience was the Fukushima disaster. The PCL-S has response options ranging from 1 = *not at all* to 5 = *extremely*, and the total score (from 17 to 85) was obtained by

summing each score. Following previous studies, a total score of ≥ 44 was classified as having probable PTSD [25, 30]. In this study population, the Cronbach's alpha for the PCL-S was 0.96, indicating high internal reliability.

Smoking and drinking statuses were classified into three categories: current, former, and never. Self-rated health was assessed with the following question: “How would you rate your current health status?” and the self-rated economic situation was assessed with the following question: “How would you rate your current economic situation?”using five response options: *very good*, *good*, *fair*, *poor*, and *very poor*.

Statistical analysis

The distribution of the survey variables according to the frequency of laughter was presented as means (with standard deviations) or percentages. A chi-squared test was used to compare the proportions, and analysis of variance was used to compare the mean ages. The Jonckheere–Terpstra trend test was also used to compare the mean age among the four categories for frequency of laughter. Associations between the frequency of laughter and other factors were investigated using logistic regression analysis. For the analysis, the participants were dichotomised into low- and high-frequency laughter groups. We defined participants who reported laughing almost every day as the high-frequency laughter group (the main outcome) and all the other participants as the low-frequency laughter group. Age- and sex-adjusted odds ratios (ORs) and 95% confidence intervals (CIs) for laughing almost every day were calculated according to each variable. All variables with $P < 0.05$ were then included in the multivariate analyses. However, “living away from the family due to the disaster” and “a change in the number of family members before and after the disaster” were suggested to be associated with each other, and only “a change in the number of family members before and after the disaster” was used in the multivariate analyses. For the multivariate analyses, we used multiple imputation to handle missing data. For comparison, analyses were also performed on the subset of complete cases. To quantify the relative

contribution of lifestyle factors (e.g., recreational activity and exercise habits) to the association between disaster-related factors (e.g., change of address) and the frequency of laughter, the following formula was used [31, 32]: ($OR_{\text{multivariate model–lifestyle variable}} - OR_{\text{multivariate model}}$) / ($OR_{\text{multivariate model–lifestyle variable}} - 1$) × 100%. $OR_{\text{multivariate model}}$ was the OR for laughing almost every day in the multivariate analyses, and $OR_{\text{multivariate model–lifestyle variable}}$ was the OR for laughing almost every day after adjustment for variables without lifestyle variables. Subgroup analyses by sex and age group were also performed. All analyses were conducted using the SPSS statistical software package, version 20.0 for Windows (IBM, Armonk, NY); $P < 0.05$ was considered statistically significant.

Results

The proportion of those who laugh almost every day was 27.1% among our study population. The distribution of the frequency of daily laughter according to the survey variables is provided in Table 1. Younger people were more likely to laugh. There were differences in the distribution of the frequency of laughter according to the following factors measured in this study: sex, age group, nuclear accident experience, living away from the family due to the disaster, a change in the number of family members before and after the disaster, the number of address changes, a changed work situation, self-rated health, the number of present family members, frequency of exercise, smoking status, drinking status, mental health distress and traumatic symptoms, participation in recreational activities, and self-rated economic situation.

The association of frequency of laughter with disaster-related, socioeconomic, and lifestyle factors

The results of the age- and sex-adjusted analysis are presented in Table 2. The aforementioned factors were significantly associated with the frequency of laughter after adjustment for age and sex.

The results of multivariate analyses using multiple imputation are shown in Table 3. The percentage of missing values across the variables varied between 0 and 14.7 %. Similar results were obtained from both the analysis using multiple imputation and the complete case analysis. The percentage of missing cases in the complete case analysis was 41.7%, 37.1%, and 45.3% for total participation, men, and women, respectively. None of the variance inflation factor (VIF) values exceeded 2, meaning that there was no colinearity in the model. First, the analysis on all the participants revealed that an increase in the number of family members and fewer changes of address were still significantly associated with a high frequency of laughter (adjusted OR in comparing an increase in the number of family members with a decrease in the number of family members, 1.18, 95% CI, 1.01–1.38; and adjusted OR in comparing moving 0 times with 5 times or more, 1.22, 95% CI, 1.13–1.32). The number of present family members, good self-rated economic status, good self-rated health, lower degree of psychological distress and traumatic symptoms, a high frequency of exercise, participation in recreational activities, and sex were also associated with a high frequency of laughter. Removing recreational activity increased the magnitude of the association between a change of address and the frequency of laughter (adjusted OR in comparing moving 0 times with 5 times or more, 1.32, 95% CI, 1.22–1.42), with this variable explaining 31.2% of the association ([1.32–1.22] / [1.32–1.00] × 100). Removing the frequency of exercise did not increase the magnitude of the association between a change of address and the frequency of laughter.

In the analysis stratified according to sex, similar results were obtained. However, the association between a changed work situation and the frequency of laughter was shown only in women. Additionally, the association between the number of address changes and the frequency of laughter was predominantly found among women. Sex differences were significant in the analyses using the interaction terms (sex × changed work situation, sex × change of address; data not shown).

The results of multivariate analysis according to age group are listed in Table 4. Similar results were obtained from the analysis using both multiple imputation and a complete case analysis. The percentage of missing cases in the complete case analysis for the 20–44, 45-64,

65-74, and the 75 years and older group was 17.1%, 31.7%, 55.8%, and 69.1%, respectively. The number of present family members, good self-rated health, lower degree of psychological distress, a high frequency of exercise, participation in recreational activities, and sex were associated with the frequency of laughter, regardless of age group. However, the association between a change of address and the frequency of laughter was shown in the 45 years and older groups but not in the 20–44-year-old group. The association between a change in the number of family members and the frequency of laughter was revealed only in the 20–44-year-old group. A good economic situation was associated with a high frequency of laughter in the 74 years and younger groups but not in the 75 years and older group. The association between traumatic symptoms and the frequency of laughter were shown in the 64 years and younger groups, but not in the 65 years and older group. The association between smoking status (current smoker vs. non-smoker) and the frequency of laughter was revealed only in the 20–44-year-old group. Age differences were significant in the analyses using the interaction terms (age group × change of address, age group × change of number of family members, age group × economic situation, age group × smoking; data not shown).

Discussion

The frequency of laughter in this study population was low compared with the results from a previous large cohort studies which assessed the frequency of laughter using the same question among community-dwelling older people (65 years and older) in Japan [12, 22]. The proportion of those who laugh almost every day was approximately 26% among people 65 years and older (27% of the total population) in the current study; it was 37.7% for men and 48.6% for women in the previous studies. Although we did not investigate the frequency of laughter before the disaster among this study population, the frequency of laughter among residents of evacuation zones might have decreased due to the disaster. Of course, it is possible that there are other explanations for the differences in the prevalence of laughter

between this study population and those in the previous studies. Although the distributions of gender, drinking status, and smoking status were similar, the proportions of those who exercised once or more per week, and people with educational attainment ≥10 years were lower in this study population compared with previous studies. Nevertheless, the results of the study are consistent with those of previous cohort and observational studies, which have reported that women tended to laugh more frequently than men did [22, 33, 34].

We investigated relationships between the frequency of laughter and disaster-related, socioeconomic, and lifestyle factors among residents of evacuation zones aged 20 years and older. The results of the analysis on all the participants revealed that lifestyle factors, including a change in the number of family members and the number of address changes, were significantly associated with the frequency of daily laughter, even after adjustment for psychosocial and lifestyle variables. Self-rated economic and health statuses, the present number of family members, mental health status, exercise habits, and participation in recreational activities were also independently associated with the frequency of laughter. These findings are consistent with those of previous studies that have shown the association of laughter with mental stress, self-rated health, exercise habits, and social participation [10, 12]. However, the study populations in the previous studies were community-dwelling older adults. The current study adds to previous knowledge by revealing the association between the frequency of laughter and lifestyle and psychosocial factors in a large cohort including a broad generation of people (20 years and older) and by focusing on residents of evacuation zones.

The impact of a disaster on mental health has been well documented, and in most previous studies, PTSD and depression after disasters have been examined. To our knowledge, this is the first study to examine the frequency of laughter and its related factors after a disaster among residents of evacuation zones.

Recently, several studies have reported that positive changes following trauma and adversity, such as an increased appreciation of life and a sense of greater personal strength, are possible, and examined the components of resilience and positive coping following disasters [35, 36]. Previous studies have shown that experiencing positive emotions even in

stressful situations contributes to resilience, suggesting that humor, optimism, and relaxation are useful coping strategies [35, 37]. It is possible that laughter is also useful for positive adjustments after a disaster.

The current study is cross sectional, thus we are unable to establish a causal relationship between the frequency of laughter and participation in recreational activities. Future longitudinal studies are needed to examine the effects of recreational activities on the frequency of laughter. However, if participation in recreational activities can be useful in increasing the frequency of laughter, regardless of disaster-related stressors, community-based interventions designed to enhance social interactions in evacuation zones may be effective for promoting evacuee well-being and health. Although changes to the living environment due to the disaster seem to be inevitable, the frequency of laughter might be changed by social activities. In fact, the frequency of laughter was used to assess positive social interactions in a previous study [38]. Recently, an interventional programme using laughter yoga, a type of exercise employing self-triggered laughter, received attention for maintaining and enhancing well-being [9]. Laughter itself might be useful for managing stress and maintaining well-being after a disaster. Of course, it is imperative that governments take all possible measures to help evacuated residents live with their families and maintain their communities.

There were some sex differences in this study. The association between a changed work situation and the frequency of laughter in the multivariate analysis was shown only in women. In addition, the association between the number of address changes and the frequency of laughter was predominantly found among women. Previous studies have reported that women are more vulnerable to the impacts of disasters than men, suffering from stress or depression [19, 39, 40]. Another study reported that women evaluate traumatic events more negatively compared with men [41]. Women might be more vulnerable to a change in social networks or living conditions [42, 43]. In other words, in the pre-disaster period, women tended to laugh frequently with their neighbours or co-workers, and a changed work situation and change of address may have had a substantial influence on

women. Before the disaster, men may not have laughed as much in neighbourly relationships or work places.

Multivariate analyses revealed several differences among the age groups. The association between the number of address changes and the frequency of laughter was not found in the 20–44-year-old group. However, the association between an increase in the number of family members and the frequency of laughter was found only in the 20–44-year-old group; a potential hypothesis is a difference in the number of family members. The mean numbers of present family members were 3.5 in the 20–44-year-old group and 2.9, 2.8, and 2.9 in the 45–64-, 65–74-, and ≥ 75-year-old groups, respectively. The National Institute of population and Social Security Research in Japan reported that the proportion of those who talk with their family members decreased with age after participants were in their fifties, and the proportion of those who talk with their neighbours increased with age [44]. Younger generations might have conversation often enough with their family members to laugh, and the influence of an address change might not be found. By contrast, for older generations, it might be necessary to have conversations with neighbours to laugh, and the change of address might have an impact. In addition, in the 20–44-year-old group, an increase in the number of family members is probably the birth of a baby, resulting in an increase in the frequency of laughter. The association between a good economic situation and a high frequency of laughter was shown in the 74 years and younger groups but not in the 75 years and older group. It is suggested that the economic and financial impacts of the disaster were severe among younger generations, because many younger people experienced a changed work situation, including unemployment. Therefore, the economic situation might be associated with the frequency of laughter in the 74 years and younger groups but not in the 75 years and older group. For older generations, other factors such as health status and living conditions may be more important than economic status to laughing frequently. The association between having traumatic symptoms and a low frequency of laughter was also shown in the 64 years and younger groups. A previous study reported some age differences in traumatic symptoms (e.g., prevalence and severity of symptoms, comorbidities) [45]. The

effects of having traumatic symptoms on behaviour in daily life might differ depending on the generation.

There are several limitations in this study. First, the response rate was not high. Therefore, generalizability of the results in this study may be limited. Compared to the target population (all residents of evacuation zones aged 20 years and older), the distribution of genders in this study population was similar, but differences were present in the age distribution. The percentage of individuals aged 65 years and older was about 32% in the target population, whereas the percentage in the present study population was 43.2%. In addition, previous study has suggested that people with mental complaints are less likely to respond to a survey [46]. It is possible that residents who were in a bad mental state did not answer the survey. Second, the frequency of daily laughter was evaluated using a single self-reported question. It is possible that the perceived frequency of laughter is different from the actual frequency. Third, information on the frequency of laughter before the disaster was not obtained; therefore, a comparison between before and after the disaster was impossible. In addition, because of the cross-sectional design, the results of this study could not be used to determine a causal relationship. However, it is unlikely that people who laugh frequently experience fewer changes of address or an increase in the number of family members. A change caused by a disaster might influence the frequency of laughter. We cannot exclude the possibility of reverse causation between the frequency of laughter and other factors such as participation in recreational activities, self-rated health, and mental health distress. People who laugh a lot might participate in more social activities and have good health status. Fourth, we only obtained the number of family members before and after the disaster and did not ask the reason for the change; therefore, there might be various situations. Further studies are needed to examine in detail the changes to the number of family members.

In conclusion, increases in the number of family members and fewer address changes were significantly associated with a high frequency of daily laughter, even after adjusting for psychosocial factors, among the residents of evacuation zones after the Fukushima disaster. On the other hand, participation in recreational activities was also significantly associated with a high frequency of laughter, regardless of disaster-related stressors (e.g., change of

address), especially for those aged 45 years and older. Future longitudinal studies are needed to examine what factors can increase the frequency of laughter, which would be useful in promoting health in the residents of evacuation zones.

Recently, birth rates in Fukushima have risen (Report of Vital Statistics. Ministry of Health Labour and Welfare. http://www.mhlw.go.jp/toukei/list/81-1a.html. Accessed: 13th February 2017), which possibly increases the frequency of laughter. Fortune may have come to residents of Fukushima who laugh.

Compliance with ethical standards

Conflict of interest

The authors declare that they have no conflict of interest.

Ethical standards

The study protocol was approved by the Ethics Review Committee of Fukushima Medical University (No. 1316). The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

Authors' contributions

M.H. analysed the data and wrote the manuscript. M.H., T.O., S.Y., M.M., M.A. and K.K. designed the study. T.O., S.Y., M.Ha. and H.N. contributed to the data collection. M.H. ,T.O., and M.Mu. interpreted the results. All authors have approved the final manuscript.

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Table 1. Individual characteristics and survey variables according to the frequency of laughter

		Frequency of laughter				
	n	Almost everyday	1–5 per week	1–3 per month	Almost never	P value
Participants, N (%)	52,320	14,203 (27.1)	21,139 (40.4)	10,215 (19.5)	6,763 (12.9)	
Age, mean (SD), years		57.2 (18.5)	59.2 (17.4)	60.9 (16.0)	62.8 (16.0)	＜0.001*
Sex, N (%)						
Men	23,115	5,615 (39.5)	8,915 (42.2)	4,876 (47.7)	3,709 (54.8)	＜0.001
Women	29,205	8,588 (60.5)	12,224 (57.8)	5,339 (52.3)	3,054 (45.2)	
Age (%)						
20–44	11,962	29.6	23.8	17.3	14.2	＜0.001
45–64	17,757	28.6	33.1	39.2	39.8	
65–74	11,263	21.0	21.6	22.5	20.9	
≥ 75	11,338	20.9	21.5	20.9	25.1	
Self-rated health (%)						
Very poor	1,040	0.7	1.2	2.2	6.8	＜0.001
Poor	8,893	9.4	15.0	22.3	31.1	
Fair	31,464	58.1	63.8	61.4	51.0	
Good	7,595	22.1	14.8	9.4	5.5	
Very good	1,680	6.8	2.4	1.2	1.3	
Missing data	1,648	2.9	2.8	3.5	4.2	
Number of family members (present) (%)						
1	6,933	10.2	12.9	14.9	18.3	＜0.001
2	16,942	29.9	33.1	33.7	33.3	
3	10,389	19.8	20.0	20.0	19.1	
4	7,113	15.3	13.9	12.2	11.1	
5	3,823	9.1	7.2	6.7	4.9	
6 or more	4,206	10.7	7.7	6.9	4.9	
Missing data	2,914	5.0	5.2	5.6	8.1	
Exercise habits (%)						
Never	24,614	42.3	43.5	49.8	63.7	＜0.001
Once per week	8,072	13.6	16.6	18.6	10.7	
2–4 times per week	11,218	20.2	25.2	20.2	14.0	
Everyday	7,495	21.9	13.0	9.6	9.7	
Missing data	921	2.0	1.6	1.7	1.8	
Smoking status (%)						
Current smoker	9,133	16.7	16.6	18.8	19.7	＜0.001
Ex-smoker	10,412	18.2	19.9	20.1	23.0	
Non-smoker	25,105	50.9	49.8	45.4	40.1	

Missing data	7,670	14.2	13.7	15.7	17.1	
Drinking status (%)						
Current drinker	21,201	39.5	41.4	42.0	37.9	＜0.001
Ex-drinker	1,576	2.6	2.7	3.1	4.8	
Non-drinker	25,750	50.4	49.1	47.7	49.3	
Missing data	3,739	7.4	6.9	7.3	8.0	
Mental health distress (%)						
K6 ≥ 13	5,888	4.5	8.6	15.5	27.4	＜0.001
K6 < 13	42,439	88.6	84.3	76.6	62.2	
Missing data	3,993	6.9	7.1	7.9	10.4	
Traumatic symptoms (%)						
PCL-S ≥ 44	8,735	10.1	14.3	21.2	31.3	＜0.001
PCL-S < 44	39,150	82.2	77.8	70.0	57.6	
Missing data	4,435	7.7	8.0	8.8	11.1	
Recreational activity (%)						
Seldom or never	31,768	51.0	57.8	66.3	81.8	＜0.001
Sometimes	15,133	32.6	31.9	27.4	14.1	
Usually	4,659	14.7	9.0	4.9	2.6	
Missing data	760	1.7	1.3	1.4	1.5	
Nuclear accident experience (%)						
Yes	46,328	87.2	89.1	89.3	88.6	＜0.001
No	5,992	12.8	10.9	10.7	11.4	
Living away from the family (%)						
Yes	19,002	31.8	36.6	39.5	40.2	＜0.001
No	31,626	65.3	60.4	57.2	55.2	
Missing data	1,692	2.9	3.0	3.3	4.6	
Number of family members (change) (%)						
Decrease	20,020	34.5	38.5	41.3	41.0	＜0.001
No change	22,741	45.6	44.0	41.4	40.4	
Increase	3,531	8.5	6.7	5.4	5.1	
Missing data	6,028	11.4	10.8	11.8	13.5	
Change of address (%)						
5 times or more	13,707	21.6	26.6	28.9	30.3	＜0.001
3–4 times	16,053	29.1	30.9	31.8	31.8	
1–2 times	12,228	25.6	23.1	22.1	21.5	
0 times	5,347	12.6	10.1	8.8	7.9	
Missing data	4,985	11.2	9.3	8.4	8.4	
Changed work situation (%)						

Yes	22,681	40.6	43.4	45.5	45.6	＜0.001
No	22,205	46.2	42.7	40.4	36.9	
Missing data	7,434	13.2	13.9	14.1	17.5	
Self-rated economic situation (%)						
Very poor	8,058	11.9	13.7	16.7	26.0	＜0.001
Poor	14,885	23.9	29.5	32.1	29.3	
Fair	23,272	51.2	45.6	40.5	32.9	
Good	1,197	3.0	2.4	1.8	1.0	
Very good	402	1.4	0.6	0.4	0.5	
Missing data	4,506	8.6	8.2	8.4	10.2	

Data are N (%) or mean (SD). *P for trend. Abbreviations: SD = Standard deviation, K6 = Kessler 6, PCL-S = Posttraumatic Stress Disorder Checklist–Stressor-Specific Version.

Table 2. Factors associated with "laughing almost every day" after age and sex adjustment

		OR	95% CI
Living away from the family	yes	1	
	no	1.38	1.32 - 1.43
Number of family members (change)	decrease	1	
	no change	1.28	1.23 - 1.34
	increase	1.54	1.43 - 1.66
Number of family members (present)	1	1	
	2	1.33	1.24 - 1.42
	3	1.37	1.28 - 1.47
	4	1.55	1.44 - 1.68
	5	1.81	1.66 - 1.98
	6 or more	2.09	1.92 - 2.28
Change of address	5 times or more	1	
	3–4 times	1.21	1.15 - 1.28
	1–2 times	1.47	1.39 - 1.55
	0 times	1.78	1.66 - 1.90
Changed work situation	yes	1	
	no	1.40	1.35 - 1.46
Nuclear accident experience	yes	1	
	no	1.31	1.23 - 1.39
Self-rated economic situation	very poor	1	
	poor	1.09	1.02 - 1.17
	fair	1.70	1.60 - 1.80
	good	2.04	1.79 - 2.32
	very good	3.72	3.03 - 4.56
Self-rated health	very poor	1	
	poor	1.57	1.28 - 1.94
	fair	3.12	2.54 - 3.83
	good	6.24	5.07 - 7.69
	very good	11.63	9.28 - 14.58
Mental health distress	K6 ≥ 13	1	
	K6 < 13	3.50	3.21 - 3.81
Traumatic symptoms	PCL-S ≥ 44	1	

	PCL-S < 44	2.11	1.98 - 2.24
Exercise habits	never	1	
	once per week	1.08	1.01 - 1.14
	2–4 times per week	1.29	1.22 - 1.36
	everyday	2.88	2.72 - 3.06
Recreational activity	seldom or never	1	
	sometimes	1.58	1.51 - 1.65
	usually	3.19	2.99 - 3.40
Smoking status	current smoker	1	
	ex-smoker	1.08	1.01 - 1.15
	non-smoker	1.15	1.08 - 1.22
Drinking status	current drinker	1	
	ex-drinker	0.97	0.86 - 1.09
	non-drinker	1.01	0.97 - 1.06

Abbreviations: OR = odds ratio, CI = confidence interval, K6 = Kessler 6, PCL-S = Posttraumatic Stress Disorder Checklist–Stressor-Specific Version.

Table 3. ORs and 95% CIs for “laughing almost every day” (multivariable-adjusted) according to sex

		Total (n = 52,320)		Men (n = 23,115)		Women (n = 29,205)	
		OR	95% CI	OR	95% CI	OR	95% CI
Age		0.99	0.99 - 0.99	0.99	0.99 - 0.99	0.99	0.99 - 0.99
Sex	men	1					
	women	1.51	1.43 - 1.59				
Number of family members (change)	decrease	1					
	no change	1.05	1.00 - 1.10	1.06	0.97 - 1.16	1.05	0.98 - 1.12
	increase	1.18	1.01 - 1.38	1.18	0.88 - 1.58	1.17	1.05 - 1.32
Number of family members (present)	reference: 1	1.10	1.08 - 1.12	1.09	1.06 - 1.12	1.11	1.08 - 1.13
Change of address	5 times or more	1					
	3–4 times	1.11	1.05 - 1.18	1.11	1.02 - 1.22	1.11	1.03 - 1.20
	1–2 times	1.20	1.13 - 1.27	1.15	1.04 - 1.26	1.23	1.14 - 1.33
	0 times	1.22	1.13 - 1.32	1.11	0.99 - 1.25	1.32	1.19 - 1.46
Changed work situation	yes	1					
	no	1.04	0.99 - 1.10	0.97	0.90 - 1.04	1.10	1.03 - 1.17
Nuclear accident experience	yes	1					
	no	1.03	0.96 - 1.10	1.00	0.90 - 1.11	1.04	0.96 - 1.14
Self-rated economic situation	very poor	1					
	poor	0.86	0.80 - 0.93	0.84	0.75 - 0.93	0.88	0.80 - 0.98
	fair	1.12	1.05 - 1.20	1.12	1.01 - 1.24	1.14	1.04 - 1.25
	good	1.20	1.05 - 1.38	1.13	0.91 - 1.39	1.28	1.06 - 1.54
	very good	2.02	1.56 - 2.60	2.08	1.48 - 2.91	1.98	1.31 - 2.97
Self-rated health	very poor	1					
	poor	1.20	0.96 - 1.49	1.42	0.98 - 2.06	1.07	0.81 - 1.42
	fair	1.72	1.38 - 2.14	2.01	1.40 - 2.89	1.55	1.18 - 2.04
	good	2.83	2.27 - 3.55	3.19	2.21 - 4.62	2.65	2.00 - 3.52
	very good	4.63	3.63 - 5.90	5.31	3.59 - 7.84	4.28	3.13 - 5.86
Mental health distress	K6 ≥ 13	1					
	K6 < 13	2.13	1.93 - 2.34	2.04	1.73 - 2.42	2.15	1.90 - 2.43
Traumatic symptoms	PCL-S ≥ 44	1					
	PCL-S < 44	1.19	1.10 - 1.28	1.19	1.06 - 1.35	1.18	1.08 - 1.30

Exercise habits	never	1									
	once per week	0.92	0.86	-	0.98	0.93	0.84	-	1.03	0.92	0.84 - 1.00
	2–4 times per week	1.08	1.02	-	1.15	1.13	1.03	-	1.24	1.05	0.98 - 1.14
	everyday	2.33	2.19	-	2.48	2.31	2.11	-	2.53	2.37	2.17 - 2.59
Recreational activity	seldom or never	1									
	sometimes	1.35	1.28	-	1.41	1.37	1.27	-	1.48	1.33	1.25 - 1.42
	usually	2.30	2.14	-	2.47	2.15	1.94	-	2.39	2.48	2.24 - 2.74
Smoking status	current smoker	1									
	ex-smoker	0.99	0.91	-	1.07	0.93	0.85	-	1.02	1.11	0.96 - 1.28
	non-smoker	0.99	0.92	-	1.06	0.96	0.87	-	1.06	1.05	0.94 - 1.18
Nagelkerke R-sq.					0.15				0.13		0.16

Abbreviations: OR = odds ratio, CI = confidence interval, K6 = Kessler 6, PCL-S = Posttraumatic Stress Disorder Checklist–Stressor-Specific Version.

Table 4. ORs and 95% CIs for “laughing almost every day” (multivariable-adjusted) according to age group

		20–44 (n = 11,962)		45–64 (n = 17,757)		65–74 (n = 11,263)		≥ 75 (n = 11,338)	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age		0.98	0.97 - 0.99	0.98	0.97 - 0.98	1.04	1.02 - 1.05	0.97	0.96 - 0.98
Gender	men	1							
	women	1.54	1.40 - 1.68	1.60	1.45 - 1.78	1.41	1.25 - 1.60	1.42	1.20 - 1.68
Number of family members (change)	decrease	1							
	no change	1.12	1.02 - 1.23	1.00	0.92 - 1.09	1.02	0.88 - 1.18	1.10	0.92 - 1.32
	increase	1.37	1.18 - 1.59	1.14	0.97 - 1.34	1.01	0.53 - 1.90	1.03	0.83 - 1.29
Number of family members (present)	reference: 1	1.04	1.01 - 1.07	1.12	1.08 - 1.15	1.12	1.08 - 1.16	1.12	1.08 - 1.15
Change of address	5 times or more	1							
	3–4 times	1.00	0.91 - 1.11	1.13	1.02 - 1.25	1.26	1.11 - 1.43	1.15	1.01 - 1.32
	1–2 times	0.97	0.86 - 1.08	1.34	1.19 - 1.53	1.35	1.18 - 1.55	1.25	1.07 - 1.45
	0 times	0.98	0.84 - 1.14	1.41	1.23 - 1.63	1.43	1.19 - 1.72	1.34	1.11 - 1.60
Changed work situation	yes	1							
	no	1.06	0.97 - 1.15	1.03	0.95 - 1.13	1.04	0.93 - 1.16	0.96	0.83 - 1.11
Nuclear accident experience	yes	1							
	no	0.90	0.77 - 1.06	0.91	0.79 - 1.04	1.02	0.89 - 1.17	1.13	1.00 - 1.28
Self-rated economic situation	very poor	1							
	poor	0.89	0.78 - 1.02	0.86	0.76 - 0.98	0.85	0.72 - 0.99	0.84	0.70 - 1.00
	fair	1.36	1.19 - 1.55	1.13	1.00 - 1.29	1.02	0.88 - 1.18	0.97	0.82 - 1.15

	good	1.39	1.09	- 1.78	1.41	1.12	- 1.79	0.91	0.65	- 1.29	1.05	0.74	- 1.50
	very good	2.84	1.89	- 4.26	1.87	1.23	- 2.84	2.34	1.37	- 4.00	1.36	0.70	- 2.65
Self-rated health	very poor	1											
	poor	0.86	0.52	- 1.41	0.80	0.54	- 1.18	1.56	0.93	- 2.61	1.70	1.10	- 2.61
	fair	1.12	0.69	- 1.82	1.15	0.78	- 1.68	2.28	1.37	- 3.78	2.52	1.65	- 3.86
	good	1.79	1.09	- 2.92	1.98	1.34	- 2.93	3.46	2.06	- 5.82	4.27	2.74	- 6.65
	very good	2.82	1.70	- 4.68	3.36	2.17	- 5.19	7.55	4.24	- 13.4	4.59	2.72	- 7.72
Mental health distress	K6 ≥ 13	1											
	K6 < 13	2.67	2.18	- 3.27	2.11	1.72	- 2.59	2.12	1.72	- 2.63	1.73	1.39	- 2.17
Traumatic symptoms	PCL-S ≥ 44	1											
	PCL-S < 44	1.46	1.23	- 1.74	1.54	1.30	- 1.82	1.05	0.91	- 1.21	1.17	0.99	- 1.37
Exercise habits	never	1											
	once per week	0.90	0.80	- 1.02	0.95	0.85	- 1.06	0.81	0.70	- 0.94	0.99	0.84	- 1.17
	2–4 times per week	1.17	1.02	- 1.33	1.05	0.94	- 1.16	0.96	0.85	- 1.09	1.11	0.97	- 1.28
	everyday	1.90	1.74	- 2.08	2.10	1.86	- 2.36	2.00	1.76	- 2.28	2.71	2.37	- 3.11
Recreational activity	seldom or never	1											
	sometimes	1.30	1.18	- 1.42	1.22	1.12	- 1.33	1.37	1.23	- 1.52	1.56	1.40	- 1.75
	usually	2.13	1.75	- 2.60	2.22	1.93	- 2.56	2.36	2.07	- 2.70	2.17	1.89	- 2.50
Smoking status	current smoker	1											
	ex-smoker	0.92	0.81	- 1.05	1.05	0.93	- 1.18	0.95	0.80	- 1.11	1.15	0.79	- 1.66
	non-smoker	0.82	0.75	- 0.91	1.02	0.91	- 1.15	1.03	0.87	- 1.21	1.22	0.85	- 1.74

Nagelkerke R-sq.	0.14	0.13	0.15	0.17

Abbreviations: OR = odds ratio, CI = confidence interval, K6 = Kessler 6, PCL-S = Posttraumatic Stress Disorder Checklist–Stressor-Specific Version.